Safety Topic of the Month

Nitrogen Hazards

Richmond Refinery

November 1, 2011

Learning Objectives

- Understand the uses and properties of nitrogen
- Understand the hazards of nitrogen and oxygen-deficient (inert) environments
- Learn from past fatal incidents involving nitrogen
- Understand how Richmond mitigates the hazards of nitrogen and oxygen-deficient environments

Properties of Nitrogen

- Makes up 78% of the earth's atmosphere
- Colorless, odorless, tasteless
- Inert (not reactive), not corrosive, and not flammable
- Can be delivered as a low temperature liquid (cryogenic) or as a compressed gas
- Nitrogen gas is about the same density as air – it's not lighter or heavier than air

Refinery Applications of Nitrogen

- Purge or clean equipment of gases that are toxic, corrosive, reactive, or present fire or explosion hazards, making processes safer
- Maintain an inert (not reactive) atmosphere while conducting work in a potentially flammable atmosphere

Refinery Applications of Nitrogen

- Blanket storage tanks to maintain pressure
- Maintain an inert atmosphere while loading pyrophoric materials (materials that ignite on contact with air or oxygen)
- Reduce corrosion of stored equipment

Why is Nitrogen a Hazard?

- No warning properties: colorless, odorless, non-irritating
- Displaces oxygen; classified as an asphyxiant
- One or two breaths of pure nitrogen can cause loss of consciousness:
  - when you breathe in pure nitrogen you exhale carbon dioxide without resupplying oxygen, leading to suffocation (asphyxiation)
- Standing near a vessel opening with nitrogen in the vessel can injure or kill

Effects of Nitrogen on the Body

- Excessive amounts of nitrogen will cause:
  - Dizziness
  - Nausea
  - Vomiting
  - Tingling in tongue, fingers, toes
  - Reduced awareness of surroundings
  - Unconsciousness
  - Death

Effects of Oxygen Deficiency – Nitrogen Displaces Oxygen

Table 1. Effects of oxygen deficiency on the human body.

Percent Oxygen	Physiological Symptoms
23.5	Maximum "safe level'
21	Typical oxygen concentration in air
19.5	Minimum safe level
15 - 19	First sign of hypoxia. Decreased ability to work strenuously. May induce symptoms in persons with heart, lung, or circulatory problems
12 - 15	Respiration increases with exertion, pulse up, impaired muscular coordination, perception, and judgment
10 - 12	Respiration further increases in rate and depth, poor judgment, blue lips
8 - 10	Mental failure, fainting, unconsciousness, ashen face, blue lips, nausea, vomiting, inability to move freely
6 - 8	Six minutes–50% probability of death Eight minutes–100% probability of death
< 6	Coma in 40 seconds, followed by convulsions, respiration ceases, death

Source: *Hazards of Nitrogen and Catalyst Handling*, Institution of Chemical Engineers, 2004

CSB Video – Hazards of Nitrogen Asphyxiation

- In Delaware City, DE, on November 5, 2005, a Valero Refinery suffered two boilermaker fatalities involving nitrogen in a confined space.
- A video produced by the Chemical Safety Board (CSB) explains what happened and the lessons learned.

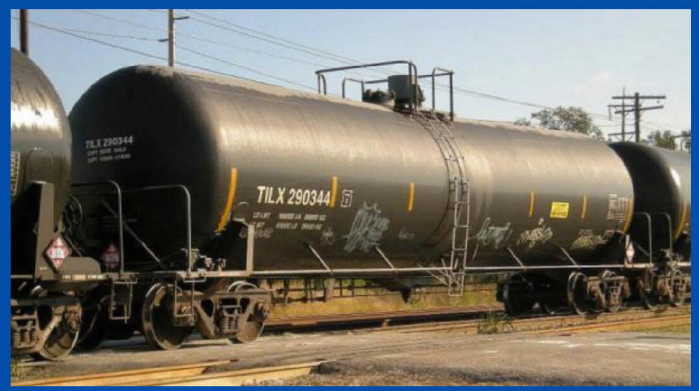
Click Here to Watch the CSB Video

How do you know when you are entering an oxygen-depleted environment?

How do we control entry into the area around an inert confined space?

Case Study – Tank Car Offloading with Nitrogen

- Tank car at a refinery contained white mineral oil; an employee started cleaning the tank
- The mineral oil was offloaded by injecting nitrogen gas into the tank car
- The nitrogen was still present when the employee started to clean the tank car; the employee was asphyxiated



What are the tasks that you do that involve nitrogen?

Note: All of these case studies are non-Chevron events.

Case Study – Mix Up of Air and Nitrogen

- The atmosphere inside a coated tank was tested and ventilated the day before work was to be performed inside
- The next day a contractor entered the tank to clean it and collapsed
- Two plant employees attempted rescue and were overcome by nitrogen; all three workers died
- The tank had mistakenly been ventilated with nitrogen instead of compressed air

What systems does Richmond have in place to prevent this type of event from happening?

Case Study – Covering End of Active Reactor Piping

- Two workers at the Union Carbide Taft/Star Mfg Plant were conducting black light inspection on the open end of a 48” diameter pipe
- Workers put black plastic sheeting over the end of the pipe to create shade for the black light testing
- Nitrogen flowed through piping of the reactor into the 48” pipe; two workers were asphyxiated

Do you ever work with equipment that has been purged with nitrogen?

What precautions do you take?

How Richmond Mitigates the Hazards of Nitrogen and Oxygen-Deficient Atmospheres

Assess, Analyze and Act to prevent incidents by using safeguards/hazard controls:

- LPSA, JSA, JJSV, Stop Work Authority, Procedures, Operating Standards, MOC, HSE, PSSR, Refinery Instructions, and Safe Work Practices

SAFEGUARDS

- Complete a written entry permit prior to starting work
- Monitor for oxygen concentration before and during entry
- Control access into affected nitrogen area – entry attendant/hole watch

How Richmond Mitigates the Hazards of Nitrogen and Oxygen-Deficient Atmospheres

SAFEGUARDS (continued)

- Post warning signs and barricades
- Communication equipment: two-way radio
- Control flow and temperature of nitrogen
- Emergency Action and Rescue Plan
- Rescue equipment: lifeline, retrieval harness, hoist
- Training on nitrogen and confined space hazards

How Richmond Mitigates the Hazards of Nitrogen and Oxygen-Deficient Atmospheres

SAFEGUARDS (continued)

- Personal protective equipment (PPE) – respiratory protection
- Labeling/Identification of nitrogen bottles, pipelines, valves
- Verification of Grade D breathing air
- Air hose couplings must be incompatible with hose couplings for nitrogen (RI-613)

Review TOP Lessons Learned

- Learning from our past incidents will help us prevent them in the future.
- Please take a few minutes to review the latest TOP lessons learned.

Click Here to Review TOP Lessons Learned